CLAIMS

We claim:

Sub A4 1. A method for creating a narrow linewidth hybrid semiconductor laser comprising:

using silicon-oxide and silicon-oxynitride based external feedback elements;

attaching said narrow linewidth hybrid semiconductor laser to a waveguide; and

soldering a semiconductor optical gain chip that acts as the internal element to a micromachined silicon bench.

2. The method of claim 1 wherein said external feedback elements use Bragg gratings.

Sub B1 3. The method of claim 2 wherein said Bragg gratings are formed by the coupling of a first Bragg grating and a second Bragg grating to a main waveguide trunk.

4. The method of claim 3 wherein said first Bragg grating and said second Bragg grating are formed by the periodic variation of the refractive index of said first Bragg grating and said second Bragg grating.

5. The method of claim 1 wherein said narrow linewidth hybrid semiconductor laser is attached to a said waveguide by a flip-chip aligner-bonder.

6. The method of claim 1 wherein said narrow linewidth is in the tens of kHz range.

7. The method of claim 1 wherein said narrow linewidth hybrid semiconductor laser is tunable to facilitate locking to a cavity.

8. The method of claim 1 wherein the hybridization method used to create said narrow linewidth hybrid semiconductor laser is achieved in miniature micromachined units.

9. The method of claim 1 wherein said semiconductor optical gain chip is coupled into a silicon-oxide/silicon-oxinitride/silicon-oxide waveguide.

10. The method of claim 9 wherein said waveguide terminates in a feedback element.

11. The method of claim 9 wherein said silicon-oxide/silicon-oxinitride/silicon-oxide interface is coated with an antireflection coating in order to further reduce loss and scattering at said interface.

12. The method of claim 3 wherein said waveguide is tailored to match said gain chip in order to further reduce loss due to mismatch of modes of said waveguide and said gain chip.

13. The method of claim 12 wherein said waveguide and said gain chip are precisely aligned to each other in order to further reduce loss due to mismatch of modes of said waveguide and said gain chip.

14. The method of claim 13 wherein said precise alignment in the vertical direction is achieved through the use of micromachined stand-offs.

15. The method of claim 13 wherein said precise alignment in the horizontal direction is achieved during the soldering operation through the use of said flip-chip aligner-bonder.

16. An apparatus for creating a narrow linewidth hybrid semiconductor laser comprising:

the use of silicon-oxide and silicon-oxynitride based external feedback elements;
said narrow linewidth hybrid semiconductor laser attached to a waveguide; and
a semiconductor optical gain chip soldered to a micromachined silicon bench.

17. The apparatus of claim 16 wherein said external feedback elements use Bragg gratings.

18. The apparatus of claim 17 wherein said Bragg gratings are formed by the coupling of a first Bragg grating and a second Bragg grating to a main waveguide trunk.

19. The apparatus of claim 18 wherein said first Bragg grating and said second Bragg grating are formed by the periodic variation of the refractive index of said first Bragg grating and said second Bragg grating.

20. The apparatus of claim 16 wherein said narrow linewidth hybrid semiconductor laser is attached to said waveguide by a flip-chip aligner-bonder.

21. The apparatus of claim 16 wherein said narrow linewidth is in the tens of kHz range.

G

22. The apparatus of claim 16 wherein said narrow linewidth hybrid semiconductor laser is tunable to facilitate locking to a cavity.

23. The apparatus of claim 16 wherein the hybridization method used to create said narrow linewidth hybrid semiconductor laser is achieved in miniature micromachined units.

24. The apparatus of claim 16 wherein said semiconductor optical gain chip is coupled into a silicon-oxide/silicon-oxinitride/silicon-oxide waveguide.

25. The apparatus of claim 24 wherein said waveguide terminates in a feedback element.

26. The apparatus of claim 24 wherein said silicon-oxide/silicon-oxinitride/silicon-oxide interface is coated with an antireflection coating in order to further reduce loss and scattering at said interface.

27. The apparatus of claim 18 wherein said waveguide is tailored to match said gain chip in order to further reduce loss due to mismatch of modes of said waveguide and said gain chip.

28. The apparatus of claim 27 wherein said waveguide and gain chip are precisely aligned to each other in order to further reduce loss due to mismatch of modes of said waveguide and said gain chip.

29. The apparatus of claim 28 wherein precise alignment in the vertical direction is achieved through the use of micromachined stand-offs.

30. The apparatus of claim 28 wherein precise alignment in the horizontal direction is achieved during the soldering operation through the use of said flip-chip aligner-bonder.